

MOKELUMNE RIVER, CAL.

LETTER

FROM

THE SECRETARY OF WAR,

TRANSMITTING,

WITH A LETTER FROM THE CHIEF OF ENGINEERS, REPORTS ON PRELIMINARY EXAMINATION AND SURVEY OF MOKELUMNE RIVER, CAL., WITH A VIEW TO ITS IMPROVEMENT FROM THE GALT-NEW HOPE BRIDGE TO A POINT AT OR NEAR WOODBRIDGE.

SEPTEMBER 10, 1914.—Referred to the Committee on Rivers and Harbors and ordered to be printed, with illustrations.

WAR DEPARTMENT,
Washington, September 9, 1914.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

SIR: I have the honor to transmit herewith a letter from the Chief of Engineers, United States Army, of yesterday's date, together with copies of reports from Maj. S. A. Cheney, Corps of Engineers, dated October 16, 1911, and April 2, 1914, with maps, upon a preliminary examination and survey, respectively, of Mokelumne River, Cal., with a view to its improvement from the Galt-New Hope Bridge to a point at or near Woodbridge, made by him in compliance with the provisions of the river and harbor act approved February 27, 1911.

Very respectfully,

LINDLEY M. GARRISON,
Secretary of War.

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, September 8, 1914.

From: The Chief of Engineers, United States Army.

To: The Secretary of War.

Subject: Preliminary examination and survey of Mokelumne River, Cal.

1. There are submitted herewith, for transmission to Congress, reports dated October 16, 1911, and April 2, 1914, by Maj. S. A. Cheney, Corps of Engineers, on preliminary examination and survey, respectively, of Mokelumne River, Cal., with a view to its improvement from the Galt-New Hope Bridge to a point at or near Woodbridge, authorized by the river and harbor act approved February 27, 1911.

2. The Mokelumne River rises in the Sierra Nevada Mountains and empties into the San Joaquin River. It has been improved by the United States since 1884, and up to June 30, 1913, expenditures aggregating \$29,669.65 have been applied to obtaining and maintaining low-water steamboat channels by removing snags, overhanging trees, and occasional dredging. A depth of 6 feet has been obtained up to New Hope Landing, a distance of 14 miles above the mouth, and a depth of about 3 feet to a point about $2\frac{1}{2}$ miles above the Galt-New Hope Bridge. The improvement now desired is the extension of navigation from the Galt-New Hope Bridge to Woodbridge, a distance of about 14 miles. The district officer reports upon different methods of improvement, and he concludes that it is impracticable to improve the river for navigation from the Galt-New Hope Bridge to Woodbridge at a cost which would be justified by the resulting benefits to navigation, and therefore he reports the locality as unworthy of improvement by the General Government. The division engineer concurs in this opinion.

3. These reports have been referred, as required by law, to the Board of Engineers for Rivers and Harbors, and attention is invited to its report herewith, dated July 27, 1914, concurring in the views of the district officer and the division engineer.

4. After due consideration of the above-mentioned reports I concur with the views of the district officer, the division engineer, and the Board of Engineers for Rivers and Harbors, and therefore report that the improvement by the United States of Mokelumne River, Cal., with a view to its improvement from the Galt-New Hope Bridge to a point at or near Woodbridge is not deemed advisable at the present time.

DAN C. KINGMAN,
Chief of Engineers, United States Army.

REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS
ON SURVEY.

[Third indorsement.]

THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
July 27, 1914.

To the CHIEF OF ENGINEERS, UNITED STATES ARMY.

1. The survey of the Mokelumne River, recommended by the board under date of January 2, 1912, has been made, and it is found that the length of the reach between the Galt-New Hope Bridge and Woodbridge is 14 miles. The district officer describes two projects of improvement. The first involves open-river methods, and has in view a navigable channel with a depth of about 3 feet. In order to secure this depth through the low-water season the natural flow of the river would have to be augmented by storage water to the amount of 150,000 acre-feet. The maximum available storage on the Mokelumne watershed is about 234,000 acre-feet, and it appears that all of this will eventually be required for irrigation purposes. The estimated cost of the reservoirs alone to provide for navigation would be upward of \$5,000,000, and with the open-channel improvement complete would cost somewhere between \$7,500,000 and \$10,000,000.

2. The second project is for a slack-water improvement, involving the construction of one lock and dam at a point about 5 miles above the Galt-New Hope Bridge and the deepening of the channel for about 3 miles below the lock and for $3\frac{1}{2}$ miles below Woodbridge. The cost of this project is estimated at \$558,900, with annual maintenance of \$10,000.

3. A third project is mentioned in the report of the assistant engineer, which provides for straightening and deepening the channel to tide level from the Galt-New Hope Bridge for a distance of about $4\frac{1}{2}$ miles and the construction of a dam at the upper end of the improved section. The estimate for this project is \$200,100, with an annual maintenance charge of \$2,000. This plan is advocated by Judge Marion De Vries, who appeared before the board on May 19 with Hon. Charles F. Curry, Member of Congress, in response to notice to interested parties of the district officer's unfavorable report. Early correspondence by the district officer with State officials indicated that local cooperation could not be obtained in carrying out the improvement contemplated. Judge De Vries, however, stated at the last hearing that he thought cooperation by the State could certainly be secured to the extent of 50 per cent of the cost of the work. This led to further correspondence with the State authorities. Attention is invited to the letter of the State engineer, dated July 8, 1914, from which it appears that no cooperation can be expected unless the matter is taken up and acted upon favorably by the State legislature.

4. The district officer considers it impracticable to improve the Mokelumne River for navigation from the Galt-New Hope Bridge to Woodbridge at a cost which would be justified by the resulting benefits to navigation, and therefore he reports the locality as unworthy of improvement by the General Government. The division engineer concurs in this view.

5. From the information now available, it appears that the cost of improving the Mokelumne River by any of the plans presented would

be very high in proportion to the extent of river improved and the amount of commerce that might reasonably be expected to follow. The least expensive plan, which would extend navigation only about $4\frac{1}{2}$ or 5 miles, is estimated to cost at the rate of approximately \$45,000 per mile. This improvement would not reach any commercial center or large field of development, and while it would be of some advantage to the immediate locality, it is believed that the benefits would be small when compared with the great cost of the work. Moreover, it appears that the waters of the Mokelumne River are in great demand for irrigation as well as for navigation, and on account of the small flow during the dry seasons and the limited storage available the supply is insufficient for both purposes.

6. In view of all the circumstances, the board reports, in concurrence with the views of the district officer and the division engineer, that it is not advisable at this time for the United States to undertake the improvement of the Mokelumne River between the Galt-New Hope Bridge and Woodbridge, even if local cooperation can be secured.

7. In compliance with law, the board reports that there are no questions of terminal facilities, water power, or other subjects which could be coordinated with the project proposed in such manner as to render the improvement advisable in the interests of commerce and navigation.

For the board:

LANSING H. BEACH,
Colonel Corps of Engineers,
Senior Member Present.

PRELIMINARY EXAMINATION OF MOKELUMNE RIVER, CAL.

WAR DEPARTMENT,
UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., October 16, 1911.

SIR: 1. In compliance with instructions contained in letter of April 7, 1911, from your office, I have the honor to submit the following report on the preliminary examination of the Mokelumne River, Cal., with a view to its improvement from the Galt-New Hope Bridge to a point at or near Woodbridge.

2. The examination of this river was made by Col. John Biddle, Corps of Engineers, in a rowboat from Woodbridge to the Galt-New Hope Bridge on May 13, 1911. Communications with reference to this matter had been previously sent to all persons thought to be interested and also to the board of trustees of the town of Woodbridge. At first but little interest seemed to be taken locally in the proposed improvement and it was considered that a public hearing was not necessary. Later, however, more interest in the subject was developed and arrangements were made for the public hearing, which was held at the Ray schoolhouse on July 14, 1911. At this meeting, at which this office was represented by Mr. H. L. Demeritt, assistant engineer, the Mokelumne River Improvement Association was formed, which has subsequently submitted to this office a topographical map,¹

¹ Not printed.

copy herewith, showing the territory adjacent to the proposed improvement and giving information in regard to the value of the crops raised in that vicinity. On October 8 and 9, 1911, I visited the locality and inspected the river at Woodbridge and the Galt-New Hope Bridge and secured further data bearing upon the improvement from citizens of Galt and Lodi.

3. The Mokelumne River rises in the Sierra Nevada Mountains and in the lower part of its course flows through Sacramento and San Joaquin Counties. It empties into the San Joaquin River, having besides navigable connections with the sloughs forming the delta of the San Joaquin and Sacramento Rivers. The Galt-New Hope Bridge is about 20 miles above its mouth and Woodbridge about 12 miles farther upstream.

4. The Mokelumne River from Woodbridge to its mouth was first reported on by Col. G. H. Mendell on December 7, 1881, printed in the Report of the Chief of Engineers for 1882, page 2367. In that report he states that he considers that it would be unwise to attempt to make the river navigable above the Galt-New Hope Bridge. To that point the river has been improved from time to time by the United States up to a total cost of \$20,998.64 to June 30, 1910. The appropriations have been spent in snagging and dredging to a limited extent. A depth of 6 feet is obtained up to New Hope Landing, a distance of 14 miles from the mouth, and a depth of about 3 feet to the so-called head of navigation indicated on the map, which is about $2\frac{1}{2}$ miles above the Galt-New Hope Bridge. The range of the tide at Galt-New Hope Bridge is about 4 feet and the tidal influence extends approximately to the so-called head of navigation, which marks the limit of the work done by the State in conjunction with the property owners in straightening the channel and clearing it of snags.

5. The Mokelumne River between Woodbridge and the Galt-New Hope Bridge has a length of 12 to 15 miles, and the width varies from 75 to 100 feet, with occasional places of several hundred feet in width. It is lined on both sides by levees, in places immediately at the river edge, and at other points back several hundred feet. The river is very crooked. At the time of the examination the height of the water, as stated by the boatman, was 8 to 10 feet above low water. The current was about 2 to 3 miles an hour. On account of the number of bends there are frequent eddies, which, with the numerous overhanging trees and snags and logs, make navigation in present condition practically impossible.

6. The drainage basin of the Mokelumne is long and narrow, extending to the summit of the Sierras. Two-thirds of the basin lies above the 5,000-foot level, and quite a large part of it between the 7,000 and 9,000 foot elevation. The flow during the dry season results from the melting of snow on the higher parts of the basin. Most of the snow is gone by the end of July, and the flow for the remainder of the dry season is dependent upon melting snow of the higher peaks. During this time the flow is generally under 200 second-feet, and quite frequently under 100 second-feet. The fall of the river at low stages from Woodbridge to the Galt-New Hope Bridge is about 25 feet. If the river were improved by means of cut-offs and the clearing out of snags and overhanging trees, navigation to Woodbridge would be possible only during high stages of

the water, probably between the months of January and June. It is believed, however, that but little use would be made of the river if it were improved for high-water navigation only, as the principal source of freight for this river would be the crops raised in the adjacent territory that could be taken out as soon as they were harvested.

7. The State of California has cleared the river for 2 or 3 miles above the Galt-New Hope Bridge, making several cut-offs, taking out snags, and cutting away overhanging trees. This was done on the basis of the State spending 50 cents for every dollar subscribed by the protection district. In all, a total amount has been expended by the State of \$7,594.13. This has resulted in clearing up the river considerably and making it navigable during high-water stages for that distance. Also, within the last two or three years the Galt-New Hope Bridge has been rebuilt and made a drawbridge. Any improvement undertaken by the United States would probably be of the same nature. To make the river navigable during the whole year locks and dams would be necessary. Their great cost would not be warranted and, moreover, they would tend to increase the overflow over adjacent lands. It has been suggested that the river channel above the present head of navigation be deepened, so as to carry tidewater to Woodbridge. In view of the large amount of excavation involved in such form of improvement, 3 or 4 miles of which would be through hardpan and the probable expense of maintenance, it is believed that the great cost of this form of improvement would not be warranted. From an inspection of the accompanying maps,¹ submitted by the Mokelumne River Improvement Association, it would appear that along the upper part of this section of the river the land is mainly used for vineyards, while along the lower part the land is used for grain, beans, and pasture. But little water freight could be expected from the vineyard country, the principal products that would go out by water being grain, beans, and wood. Considerable shipments of these products are now made from the section of the river below the Galt-New Hope Bridge, as much as \$50,000 worth of freight per mile of frontage on the river having been sent out by water in one season. These shipments are made on light-draft barges towed by gasoline launches. Stockton is the principal point of delivery. As there is but little difference between the rail and water freight rates from this locality to Stockton, the direction that such products take is mainly a question of the cost of delivery to the rail or water shipping point. It is believed that benefits of the proposed improvement of the river would be practically confined to the riparian owners and the amount of freight that would seek water transportation would decrease progressively from the Galt-New Hope Bridge to Woodbridge.

8. The Mokelumne River has generally levees on each side encroaching somewhat on its high-water channel. The high water every year causes frequent breaks in the levees. The work done by the State in making cut-offs and in cleaning up the banks of the river facilitates the discharge of the water and it is stated has considerably added to the prevention of overflows. It is probable that any open-channel improvement of this section of the river would

¹ Not printed.

considerably improve flood conditions, while any improvement by locks and dams would have the opposite effect.

9. In view of the probable large cost of the improvement of this part of the river, as shown by work done by the State, the small amount of water during the dry season, at which time most of the crops should be moved, and the uncertainty as to whether any commerce would develop, the Mokelumne River between Woodbridge and the Galt-New Hope Bridge is not considered worthy of improvement by the United States. If the State of California, assisted by the property owners, cleans the river as far as Woodbridge, as has been done for a couple of miles above the Galt-New Hope Bridge, it might be proper for the United States to maintain the same if any commerce develops. There is no question of the development of water power or of land reclamation, except as above stated. There are no terminal facilities as there is no commerce. All land adjacent to the river belongs to private parties.

10. Three maps¹ are submitted herewith, one showing the general location of the proposed improvement, one made by the State of California showing the section of the river under consideration, and one submitted by the Mokelumne River Improvement Association showing the country tributary to this section of the river.

Very respectfully,

S. A. CHENEY,
Major, Corps of Engineers.

The CHIEF OF ENGINEERS, UNITED STATES ARMY.
(Through the Division Engineer.)

[First indorsement.]

UNITED STATES ENGINEER OFFICE, PACIFIC DIVISION,
San Francisco, Cal., October 18, 1911.

Respectfully forwarded to the Chief of Engineers, United States Army, concurring in the views expressed by the district officer.

THOS. H. REES,
*Lieutenant Colonel, Corps of Engineers,
Division Engineer.*

[Third indorsement.]

THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS,
Washington, January 2, 1912.

1. Respectfully returned to the Chief of Engineers, United States Army.

2. The lower part of the Mokelumne River, a tidal tributary of the San Joaquin, has been improved to a moderate extent by snagging and the removal of obstructions from its mouth to the Galt-New Hope Bridge, a distance of about 20 miles, at a cost of \$20,998.64. A depth of 6 feet obtains up to New Hope Landing, 14 miles from the mouth, and 3 feet to a point about 2½ miles above the Galt-New Hope Bridge. The improvement now desired is an extension of the work to a point at or near Woodbridge, a distance of about 12 miles.

3. On the lower river, where fair navigation facilities exist, the commerce amounts to about 28,000 tons. There is no traffic on the reach under consideration. It appears that the State of California has

¹ Not printed.

cleared the river for 2 or 3 miles above the Galt-New Hope Bridge, making several cut-offs, taking out snags, and cutting away overhanging trees, and that this work was done on the basis of the State spending 50 cents for every dollar subscribed by the local protection district. The amount expended by the State for its share of the work is \$7,594.13. The work has resulted in clearing up the river considerably, making it navigable during high-water stages, and the district officer states that any improvement undertaken by the United States would probably be of the same nature. The construction of locks and dams, which would be required to make the river navigable during the whole year, would involve a greater expense than would be warranted. In view of the probable large cost of the improvement of this part of the river, as shown by work done by the State, the small amount of water during the dry season, at which time most of the crops should be moved, and the uncertainty as to whether any commerce would develop, the district officer reaches the conclusion that the Mokelumne River between Woodbridge and the Galt-New Hope Bridge is not worthy of improvement by the United States. The division engineer concurs in this opinion.

4. No written statements have been received in response to the district officer's notifications of his unfavorable report, but on December 26, 1911, Judge Marion De Vries came before the board in behalf of the improvement. He stated that the improvement of this part of the river has been investigated by the State engineer of California and reported to be feasible and advisable, and that the State would be willing to bear one-half the cost. He also submitted subsequently a letter¹ bearing on the question of relative freight rates by rail and water. While the board is not sanguine that an improvement suitable for a commerce of importance can be provided at justifiable cost, it believes, in view of the offer of cooperation that the matter should be fully investigated. The board therefore recommends the authorization of such survey as may be necessary for the formulation of a plan and estimate of cost of a suitable improvement, and a further investigation of the question of local cooperation.

For the board:

Wm. T. ROSELL,
Colonel, Corps of Engineers,
Senior Member of the Board.

[Fourth indorsement.]

WAR DEPARTMENT,
OFFICE OF THE CHIEF OF ENGINEERS,
Washington, January 8, 1912.

1. Respectfully submitted to the Secretary of War.
2. This is a report on preliminary examination of Mokelumne River, Cal., authorized by the river and harbor act of February 27, 1911.
3. Inviting attention to the report of the Board of Engineers for Rivers and Harbors in the preceding indorsement, I recommend that a survey of the locality, as proposed, be authorized.

W. H. BIXBY,
Chief of Engineers, United States Army.

¹ Not printed.

[Fifth indorsement.]

WAR DEPARTMENT, January 9, 1912.

Approved.

ROBERT SHAW OLIVER,
Assistant Secretary of War.

SURVEY OF MOKELUMNE RIVER, CAL.WAR DEPARTMENT,
UNITED STATES ENGINEER OFFICE, THIRD DISTRICT,
San Francisco, Cal., April 2, 1914.

From: The District Engineer Officer.
To: The Chief of Engineers, United States Army
(Through the Division Engineer).
Subject: Survey of Mokelumne River, Cal.

1. In compliance with instructions contained in letters from the Chief of Engineers dated January 11, 1912, and indorsement of March 7, 1913, the following report on a survey of the Mokelumne River from the Galt-New Hope Bridge to Woodbridge, Cal., is submitted. The survey was made under the supervision of Mr. H. H. Wadsworth, assistant engineer, whose report, with maps of survey, is transmitted herewith. A preliminary examination report on this subject was submitted under date of October 16, 1911, to which reference is made for a general description of the physical characteristics of the watershed of the stream.

2. In the 14 miles between Woodbridge and the Galt-New Hope Bridge which it is proposed to improve for navigation the river has a narrow, crooked course through generally wooded bottoms, with steep banks, the edges of which are from 100 to 125 feet apart, the width of the stream at low water varying from 30 to 80 feet, the average width being about 60 feet. On account of the narrowness and crookedness of the stream many cut-offs will be necessary in any plan of improvement to make the channel usable for boats. The tidal range at the Galt-New Hope Bridge is 3 feet and the tidal effect disappears about 3 miles above the bridge.

3. The present project for the improvement of the Mokelumne River is indefinite; but with the funds available a depth of 3 feet at low water has generally been maintained up to the Galt-New Hope Bridge, the work done consisting of snagging, cutting of overhanging trees, and occasional dredging between New Hope Landing and the Galt-New Hope Bridge, a distance of 7 miles. Very little use for navigation has so far been made of this section of the river. Below New Hope Landing ample depths for purposes of navigation are found in both forks of the river and the several sloughs connecting these forks with the San Joaquin and Sacramento Rivers. There is a regular steamer service, two trips weekly, to New Hope Landing.

4. Two railroads traverse the area affected by the proposed improvement. The line of the Southern Pacific between Stockton and Sacramento passes through Lodi and Galt, with a spur about 2 miles long from Lodi to Woodbridge. The Western Pacific passes through New Hope about $\frac{1}{2}$ mile west of the lower end of the proposed improvement.

5. The low-water discharge of the Mokelumne River at Clements, about 15 miles above Woodbridge, has fallen as low as 25 second-feet, the average of the low flows for eight years being 65 second-feet. The maximum discharge has reached 16,700 second-feet. In dry seasons practically all of the low-water flow is taken for irrigation. The period of low discharge includes the harvest season in this locality.

6. After the cut-offs necessary to eliminate the impracticable bends have been made it is estimated that a flow of 500 cubic feet per second will be required to produce a depth of 3 feet in the rectified channel. Most of the craft now operating in the delta region require a greater depth than this, but it is possible to run light-draft steamers on 3 feet of water. To secure this discharge through the low-water season storage will be required to the amount of 150,000 acre-feet in dry years. There are about 200,000 acres of land naturally dependent upon the Mokelumne River for irrigation. To give this land complete irrigation would require the storage of upward of 325,000 acre-feet in dry years. The maximum available storage on the Mokelumne watershed is about 234,000 acre-feet. It appears that all of this will eventually be required for irrigation. Any open-channel improvement of the river will necessarily seriously interfere with irrigation. The cost of the storage reservoirs required to provide for the navigation needs alone of 500 cubic feet per second would be upward of \$5,000,000. The total cost of the open-channel improvement of the river, including the rectification of the course and the construction of storage reservoirs to provide a low-water flow of 500 cubic feet per second, would be between \$7,500,000 and \$10,000,000.

7. For the slack-water in proven ent of the portion of the river in question a project and estimate has been prepared which involves the straightening of the river, the construction of one lock with a 15-foot lift about 5 miles above the Galt-New Hope Bridge, and the deepening of the channel for about 3 miles below the lock and $3\frac{1}{2}$ miles below Woodbridge. The cost of this project is estimated at \$558,900, with annual maintenance at \$10,000.

8. In view of the foregoing, I consider it impracticable to improve the Mokelumne River for navigation from the Galt-New Hope Bridge to Woodbridge at a cost which could be justified by the resulting benefits to navigation. The Mokelumne River from the Galt-New Hope Bridge to Woodbridge is not considered worthy of improvement by the General Government.

S. A. CHENEY.

[First indorsement.]

OFFICE DIVISION ENGINEER, PACIFIC DIVISION,
San Francisco, Cal., April 4, 1914.

To the CHIEF OF ENGINEERS, United States Army:

1. Concurring in the views expressed by the district engineer officer.

THOS. H. FEES,
*Lieutenant Colonel, Corps of Engineers,
Division Engineer.*

[For Report of the Board of Engineers for Rivers and Harbors on survey, see p. 3.]

REPORT OF ASSISTANT ENGINEER WADSWORTH.

WAR DEPARTMENT,
UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., March 9, 1914.

From: H. H. Wadsworth, Assistant Engineer.
To: The District Engineer Officer, Third District, San Francisco, Cal.
Subject: Survey of Mokelumne River from the Galt-New Hope Bridge to Woodbridge, Cal.

1. A survey of the Mokelumne River from the Galt-New Hope Bridge to Woodbridge was authorized by the Secretary of War under date of January 9, 1912, and an allotment of \$1,800, the estimated cost of the survey, was made on February 6, 1912.

2. The instructions regarding report on survey and projects for improvement and maintenance called for an investigation of the question of local cooperation. Correspondence between this office and the State department of engineering brought forth a statement from the latter that it declined to take up the matter of cooperation. In consequence of this statement the survey was held up and instructions to proceed with it were not received until March 12, 1913. By the latter date it had become probable that an extensive survey of the San Joaquin River would be ordered in time to permit of some of the field work being done during the late summer and fall of 1913.

3. It therefore seemed advisable to postpone the beginning of work on this much smaller survey until a date subsequent to which the party organized for it could be employed continuously throughout the season. Field work was begun August 8 and completed October 28, 1913.

4. The mapping of the survey was done at the office after the completion of the field work. Portions of a map and notes of a survey covering this same stretch of the river made by the State department of engineering in 1908 and the topographic sheets of the United States Geological Survey were used in preparing this map.

5. The length of river channel between the limiting points of the survey is 14 miles. A few characteristic cross sections are shown on the maps, and a profile showing the low-water surface, also approximate water surfaces for other stages, has also been platted and accompanies the map of the survey. Tidal observations made during the low-water period showed an average rise and fall of about 3 feet at the Galt-New Hope bridge. The tidal effect is negligible at a point 3 miles above the bridge.

6. With the detail map, in three sheets, and the profile there is also transmitted with this report a general map of the vicinity, showing the several connecting waterways. Below the Galt-New Hope bridge to New Hope Landing (about 7 miles) there is a navigable depth at low-water season of 3 feet or more. Between these points several cut-offs have been made, and from time to time shoals have been dredged, snags removed, and overhanging trees cut down. Below New Hope Landing regular trips are made by steamers through both forks of the Mokelumne to the San Joaquin River, and via Georgiana Slough to the Sacramento River. There is also a navigable waterway via Little Connection and Potato Sloughs from Terminous on the South Fork of the Mokelumne to the San Joaquin River, used by the so-called mosquito fleet, the boats of which make daily trips between Stockton and many points in the delta region.

7. The discharge of the Mokelumne River at low stages is much too small (less than 100 cubic feet per second) to make navigation possible above tide level unless locks and dams are constructed to hold the water in successive pools. The shortening of the river that would result from making the cut-offs necessary to eliminate the numerous sharp bends would, on account of the increase of grade, increase the flow in the river necessary to produce navigable depths without locks.

8. The river is so narrow that no materially less number of cut-offs than shown on the map would suffice to permit navigation by boats drawing 2 feet of water. With the cut-offs made as indicated on map and on the upper profile of profile sheet, resulting in a comparatively uniform channel approximately 60 feet wide at the bottom and about $2\frac{1}{2}$ miles shorter than at present, the flow of the river necessary for producing a depth of 3 feet, less than which does not seem worth considering, would be about 500 cubic feet per second. The mean velocities would vary from about 1 to 2.4 feet per second.

9. The following table shows (column 2) the periods since 1904 during which the discharge of the river has been less than 500 second-feet. It will be observed that the annual period during which the flow is too small to give navigable depths varies from four to nine months, and that the harvest season is included within the period. It is evident, therefore, that to provide useful transportation by river either the low-water flow must be increased by means of storage reservoirs or that canalization must be resorted to. The table shows also (column 3) the storage capacity that would have been necessary each season to have kept the discharge from falling below 500 second-feet, entirely ignoring irrigation needs.

Season. (1)	Dates between which discharge was less than 500 second-feet. (2)	Storage required to maintain 500 second-feet flow. (3)	Storage required for complete irrigation of 200,000 acres. (4)	Storage required for combined use of irrigation and navigation (500 second-feet). (5)	Dates between which navigation would have been suspended were full irrigation needs supplied. ¹ (6)
1905-6.....	June 30-Jan. 13.....	Acre-feet. 130,000	Acre-feet. 210,000	Acre-feet. 410,000	July 15-Dec. 30, 1905.
1906-7.....	Aug. 13-Dec. 10, 1906..	70,000	130,000	260,000	Nov. 20-Dec. 1, 1906.
1907-8.....	Aug. 25-Mar. 12.....	50,000	95,000	610,000	Dec. 1, 1907-Dec. 31, 1908.
1908-9.....	July 3-Jan. 6.....	130,000	210,000	300,000	Sept. 10-Oct. 31, 1909.
1909-10.....	July 20-Nov. 20, 1909..	80,000	185,000	430,000	June 1-Dec. 31, 1910.
1910-11.....	Jan. 22-Jan. 11.....	120,000	230,000	Aug. 1, 1911-Jan., 1914.
1911-12.....	July 28-Apr. 8.....	150,000	325,000	
1912-13.....	June 25-Mar. 28.....	150,000			
1913-14.....	June 19-Jan. 1.....				

¹ With 234,000 acre-feet storage capacity for combined use of navigation and irrigation.

10. It has been estimated that about 200,000 acres of agricultural land will be dependent upon the Mokelumne for irrigation and that for this purpose $2\frac{1}{2}$ acre-feet per acre per year will be needed, or a total of 500,000 acre-feet distributed through the irrigation season. To have supplied this demand in addition to 500 second-feet for navigation, the storage capacities shown in the fifth column would have been required.

11. Studies of reservoir capacity on the Mokelumne River and tributaries heretofore made by me show the practicable limit to be about 234,000 acre-feet. Were this capacity to have been used to aid both irrigation and navigation, giving irrigation its full requirement at the above-specified rate, the amount available for navigation would have been less than the required 500 second-feet during the periods shown in the sixth column of table.

12. Something of a study has been made as to the possibility of the flow in the river being increased by seepage when large quantities of water come to be used for irrigation. Considering the topography of the country over which the irrigation water would be distributed and its relation to that along the stretch of river covered by this survey, it does not appear that seepage water could perceptibly increase the river's flow.

13. The maintenance of a flow of 500 second-feet throughout low-water seasons would greatly reduce the amount of water which is likely to be needed for irrigation even when all practicable reservoir sites are utilized. For the joint use of the water for navigation and irrigation for the greatest benefit to the community an agreement as to the extent and limitations of such use by each interest would need be arranged in some way.

PLANS FOR IMPROVEMENT.

14. For improving the river in the interest of navigation, two projects have been considered for the whole stretch covered by the survey and one for the lower $4\frac{1}{2}$ miles below a point near the north and south center line of section 7, township 5 north, range 6 east. These three projects are described below:

PROJECT NO. 1.

15. Rectify the alignment of the river from Galt-New Hope Bridge to Woodbridge and deepen channel in critical places as shown on accompanying maps and profile; channel to have a bottom width of 60 feet, with side slopes of 3 horizontal to 1 vertical for 3 feet above bottom, then $1\frac{1}{2}$ to 1 to the top. Acquire the necessary rights and construct reservoirs of 150,000 acre-feet capacity for regulating low-water flow to 500 cubic feet per second. The investigation of reservoir sites previously referred to on the Mokelumne River watershed has shown that there are none for the economical storage of large quantities of water. The amount of storage required to maintain 500 second-feet discharge would require several reservoirs, including at least one with dam 300 feet or more in height.

16. To construct these storage reservoirs alone would cost at least \$5,000,000, which is so much greater than the extension of navigation over this stretch of river would justify that no further consideration need be given this scheme. A less amount of storage, 50,000 acre-feet, would make possible the navigation of the river for about

one and one-half months during low-water period. The cost of such storage per acre-foot would be approximately the same as for the larger quantity and much greater than the resulting benefits justify.

PROJECT NO. 2.

17. Rectify the alignment substantially as in project No. 1. Deepen the channel from the Galt-New Hope Bridge about $4\frac{1}{2}$ miles, or to the north and south center line of section 7, township 5 north, range 6 east, to a depth of 3.5 feet below mean lower low water at the Galt-New Hope Bridge, or about 9 feet below present bottom at center line of section 7, thus extending tidewater and slack-water navigation to this point. Construct here a lock with a 15-foot lift. There would then be a channel of more than 3 feet depth to within 4 miles of Woodbridge. Deepen the channel over these 4 miles, so that the pool above the lock may extend to Woodbridge and have a depth of 3 feet at that point. The bed of the channel at Woodbridge would be lowered about 7 feet. The present low-water flow of the river is sufficient for the operation of the lock. The lock should be so designed that at times of high water the gates could be left open and full section of the river channel be available for the passage of floods.

PROJECT NO. 3.

18. Straighten and deepen the channel from the Galt-New Hope Bridge to the center line of section 7, township 5 north, range 6 east, as in project No. 2. Construct a dam at the head of the excavated channel up to the elevation of the present river bottom to prevent the new and deeper channel from being rapidly filled by the erosion of the river bed above. The dam would not diminish the flood-carrying capacity of the river.

ESTIMATES OF COST.

19.

Project No. 1.

Total.....	\$7,500,000 to \$10,000,000
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Project No. 2.

1,420,000 cubic yards excavation, varying in character from sand and clay to hardpan, at from 15 to 40 cents per cubic yard; average cost, 30 cents.....	426,000
Lock 60 by 300 feet, 15-foot lift.....	60,000
	486,000
Add 15 per cent for contingencies.....	72,900
	486,000
Total.....	558,900

Annual maintenance, \$10,000.

Project No. 3.

560,000 cubic yards excavation, at average cost of 30 cents.....	168,000
Dam, 10 feet high.....	6,000
	174,000
Add 15 per cent for contingencies.....	26,100
	174,000
Total.....	200,100

Annual maintenance, \$2,000.

20. The point on the Mokelumne River to which navigation would be extended by project No. 3 is about $6\frac{1}{2}$ miles from Woodbridge by wagon road. Attention is called to the fact that the distance from Woodbridge to a point on Sycamore Slough, nearly due west from Woodbridge, where the general surface of the ground is at sea level, is about $7\frac{1}{2}$ miles. This point on Sycamore Slough is by water, about 14 miles nearer Stockton and about 10 miles nearer San Francisco than is the head of navigation on the Mokelumne as proposed by project No. 3. Both the construction and maintenance of a channel 6 feet deep up Sycamore Slough to within $7\frac{1}{2}$ miles of Woodbridge would be far less expensive than to a point on the Mokelumne River equally distant.

21. In my opinion the results of this survey and estimates of cost confirm the conclusion reached in your report of October 16, 1911, on preliminary examination. Commercial and other interests do not justify the expense of improving the river for navigation in accordance with either of the above-suggested projects.

H. H. WADSWORTH,
Assistant Engineer.

LETTER FROM THE STATE ENGINEER, SACRAMENTO, CAL.

STATE OF CALIFORNIA,
DEPARTMENT OF ENGINEERING,
Sacramento, July 8, 1914.

To: Maj. S. A. Cheney, Corps of Engineers.
From: Mr. W. F. McClure, State engineer.
Subject: Maps and profiles of Mokelumne River survey.

This to acknowledge yours of July 3, consisting of maps and profiles of Mokelumne River survey, and your letter of explanation.

Referring to your clause, "through an oversight, I failed to notify you when the report was finished in order that opportunity might be had to determine the extent of cooperation that the State might desire to offer, as contemplated in the instructions of the Chief of Engineers," permit me to state that the amount of money needed for any adequate improvement of this stream is so greatly in excess of any amount which the advisory board to the department of engineering could possibly feel justified in recommending that it becomes therefore a matter to be brought to the attention of the State through its legislature.

The survey made by Mr. Wadsworth and his clear outline of report places the smallest estimate for the smallest improvement at more than \$200,000, with an annual maintenance of \$2,000. Our appropriation for general river work in the matter of bank protection for the two-year period is but \$150,000, and practically the total of this amount has either already been spent or arranged for.

The mention of the use of canals in the delta district in connection with the larger sloughs is one that appeals to me as perhaps the most practicable for adoption, inasmuch as the distance can be so materially lessened.

Very truly yours,

W. F. MCCLURE, *State Engineer.*





MOKELUMNE RIVER AND VICINITY

Showing relation to and connections
SAN JOAQUIN AND SACRAMENTO RIVE

1914
Scale
[unclear]

FREIGHT

1,000	4,000	12,000	40,000
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—Mus.

Minoes

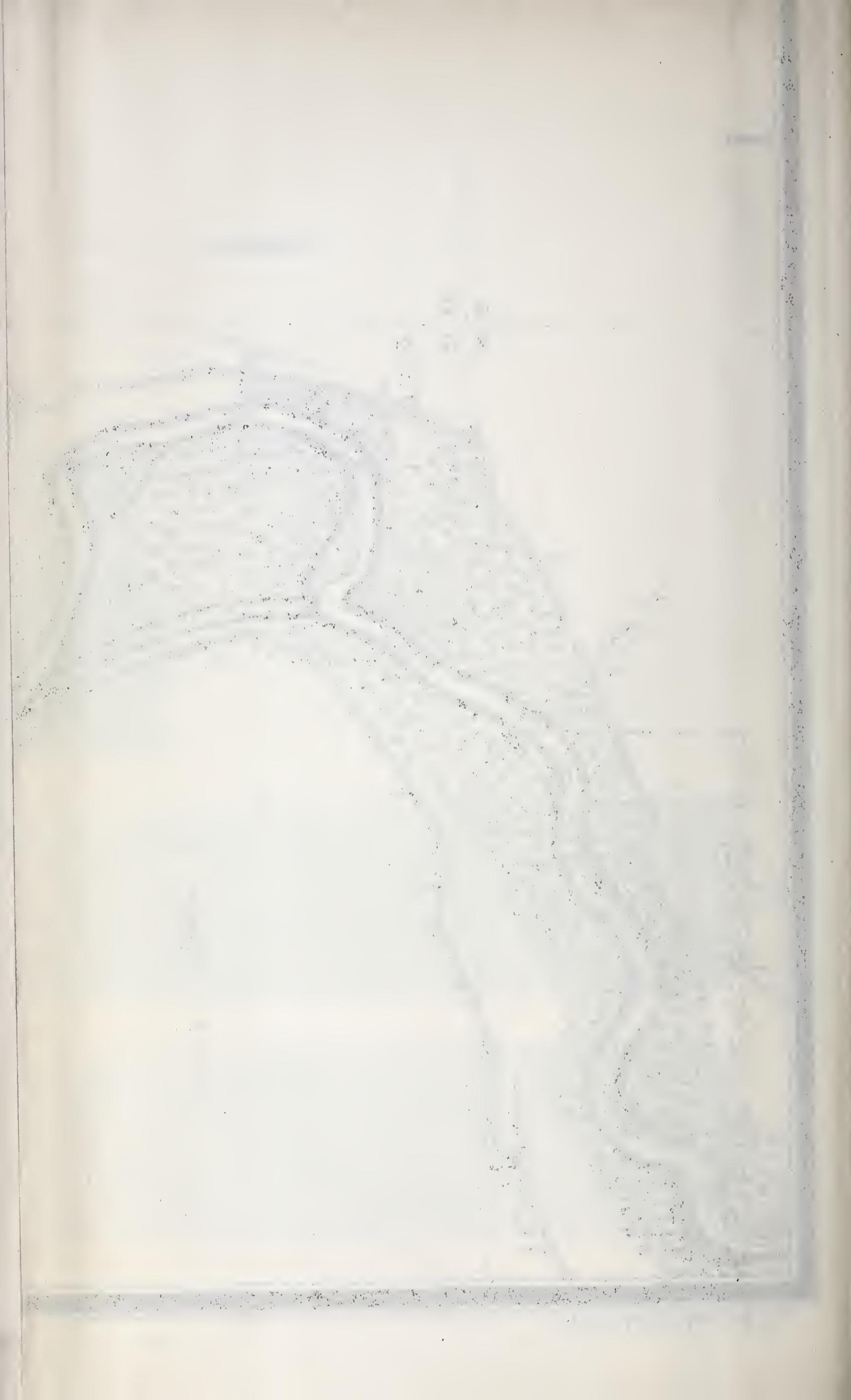
KELUMNE RIVER AND VICINITY 1914.
Doc. No. 1160; 63d Cong., 2d Sess.

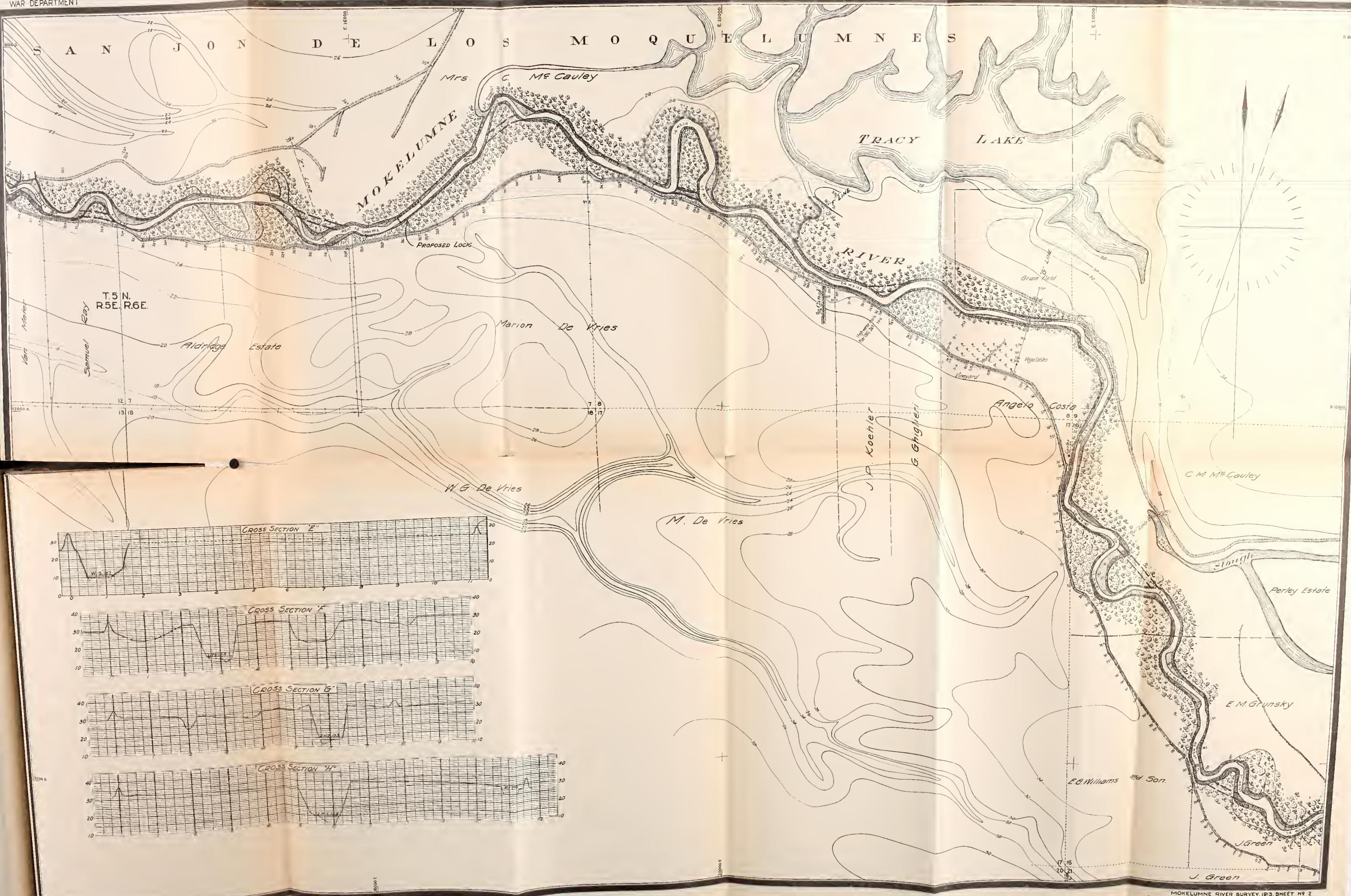
ANNA GÖTTSCHE LOWE

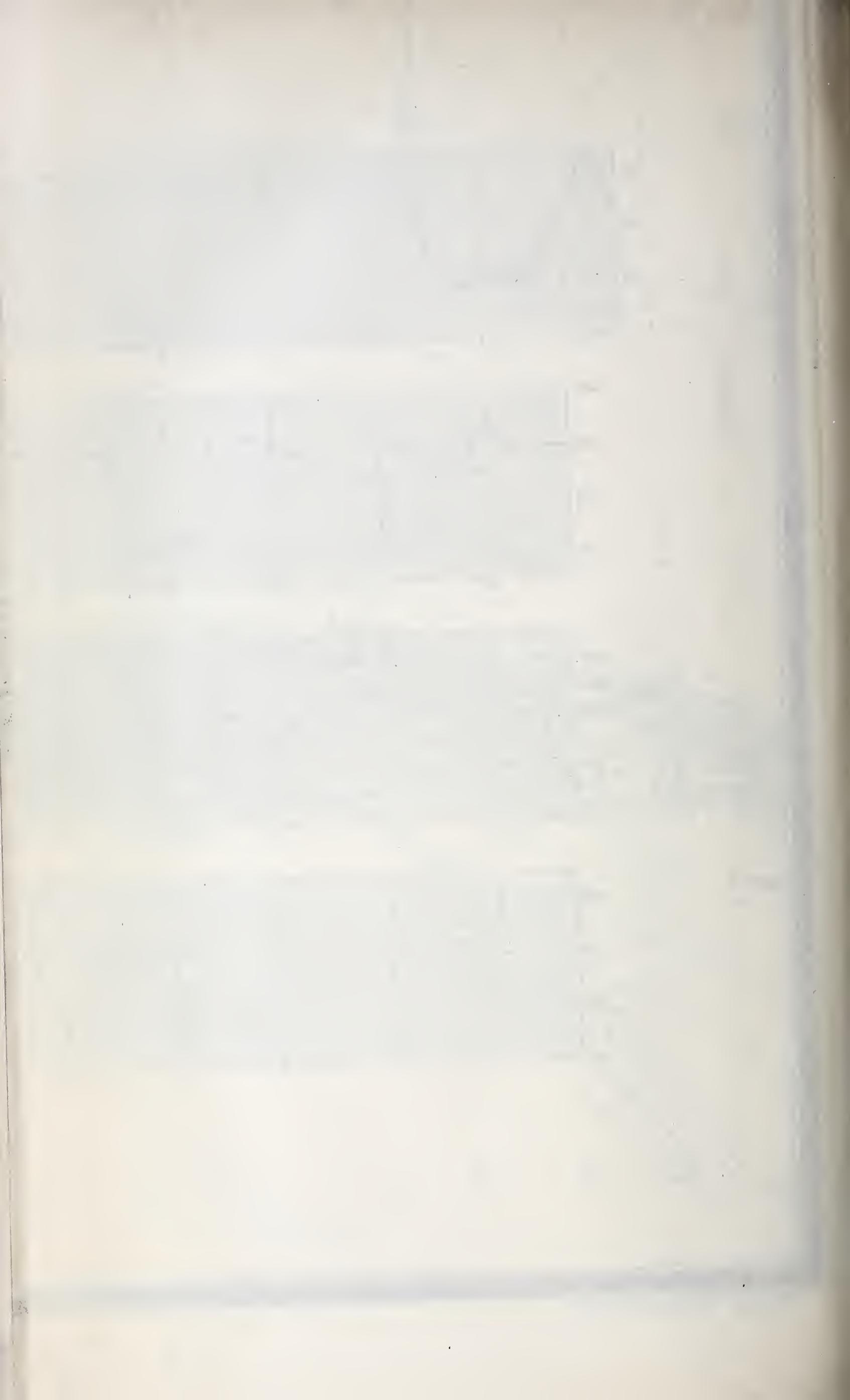
STUDIO 107

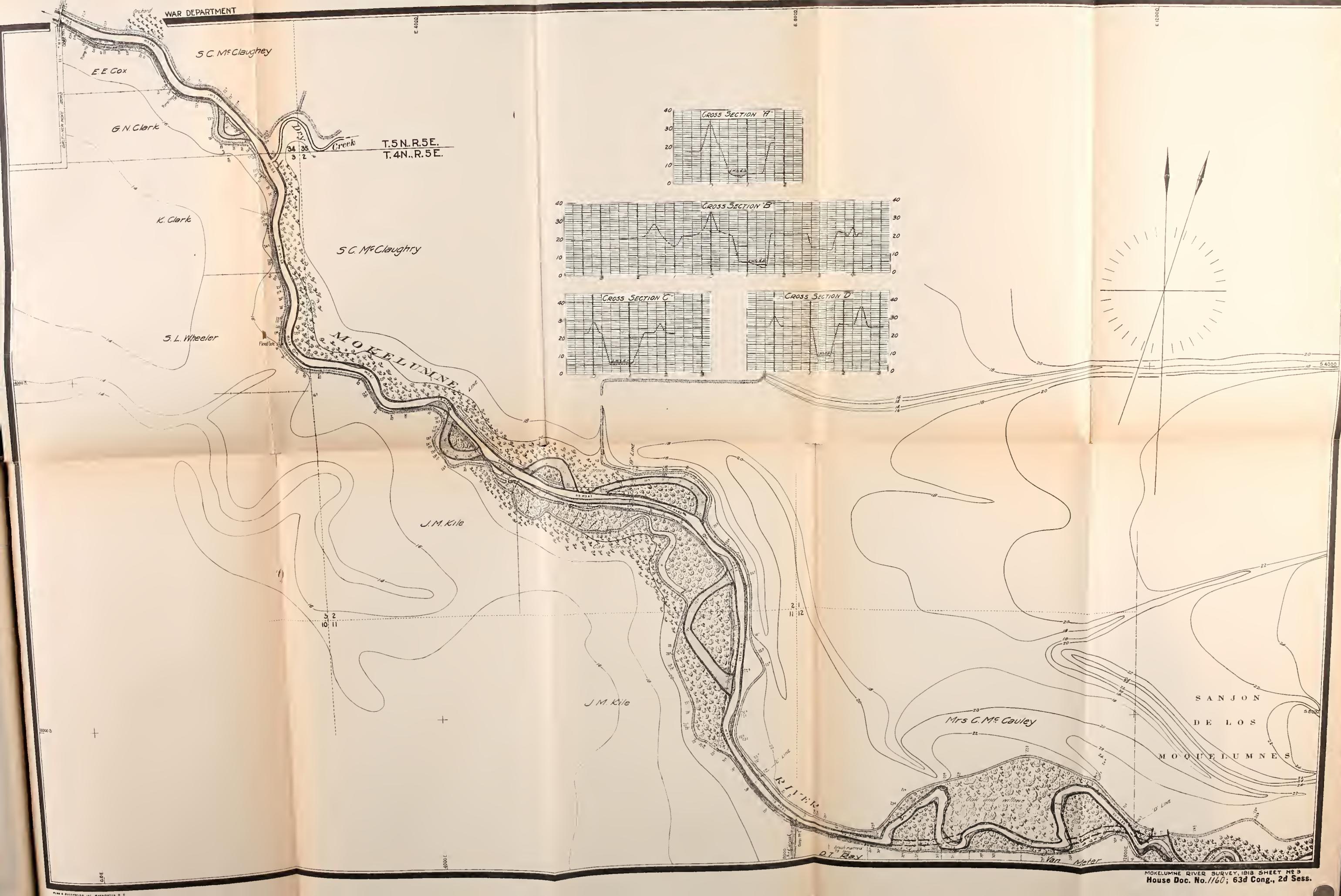
INTERVIEW WITH ANNA
GÖTTSCHE LOWE
BY
JULIA LEE

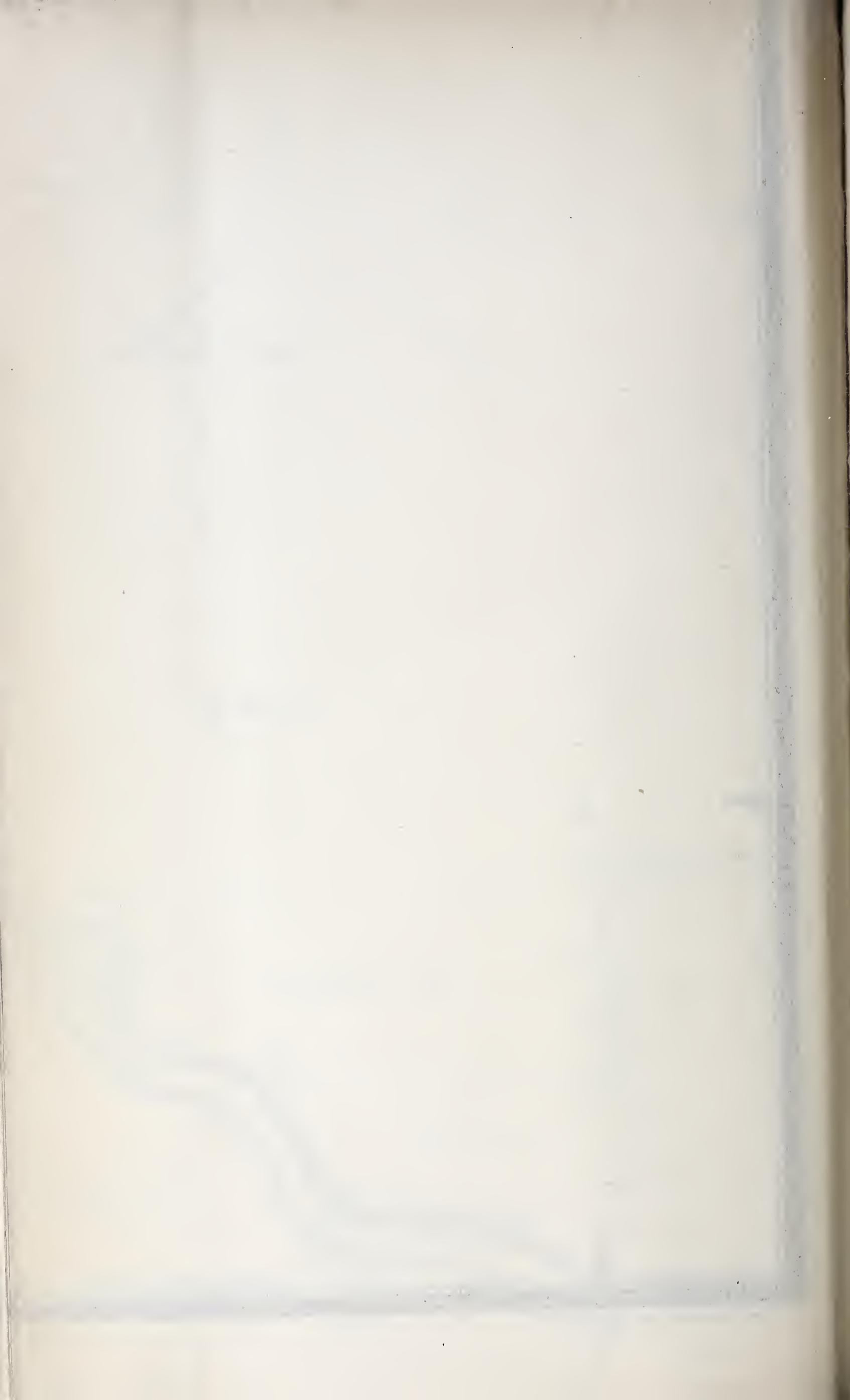










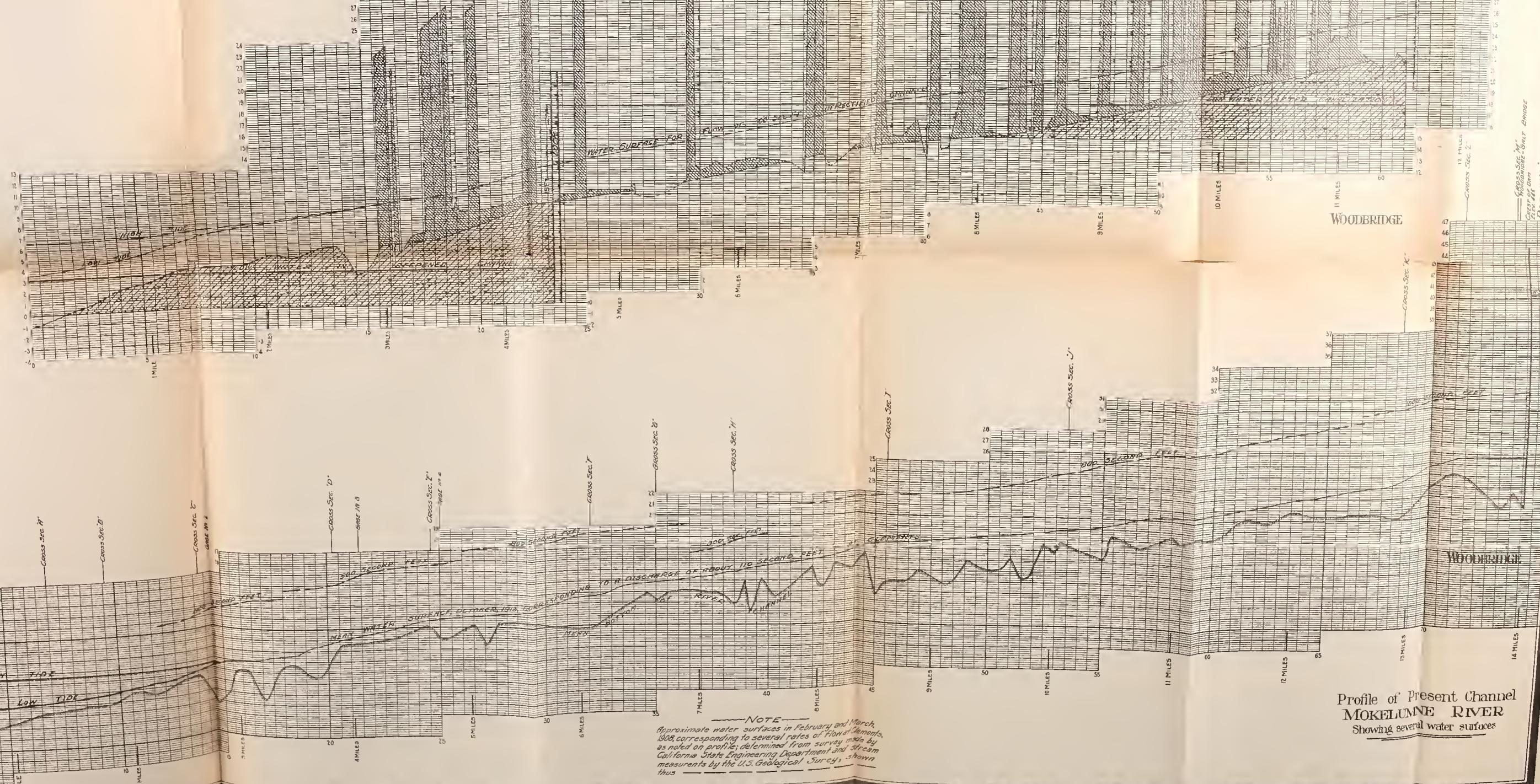


Profile of Center Line
of
Suggested Rectified Channel
MOKELOMNE RIVER

Excavation required for
Rectification shown thus.....



Additional excavation required
for slack water canalization
shown thus.....



Profile of Present Channel
MOKELOMNE RIVER
Showing several water surfaces

